A C T A A R C H A E O L O G I C A C A R P A T H I C A
VOL. L, 2015 PL ISSN 0001-5229

ANNOUNCEMENTS

MARCIN M. PRZYBYŁA

NEW MATERIALS FOR THE RECOGNITION OF SALT PRODUCTION IN THE NEOLITHIC, BRONZE AND THE EARLY IRON AGE IN WESTERN LESSER POLAND. A CASE STUDY OF SITE NO. 15 IN KRAKÓW-BIEŻANÓW IN THE CONTEXT OF OTHER ARCHAEOLOGICAL SITES IN THIS REGION

ABSTRACT

Marcin M. Przybyła 2015. *New materials for the recognition of salt production in the Neolithic, Bronze and the Early Iron Age in western Lesser Poland. A case study of site No. 15 in Kraków-Bieżanów in the context of other archaeological sites in this region*, AAC 50: 163–189.

In the following paper the author discusses ceramic materials and non-portable features associated with salt production, which were discovered at site 15 in Kraków-Bieżanów, as well as those found at other sites in western Lesser Poland, and dated back to the Neolithic, Bronze Age and early Iron Age. To certain extend, presented materials comply with the scheme of the development of local salt production that was proposed in 1970s. However, the majority of them belongs to cultural entities, whose communities until now have not been identified with salt production. This is particularly relevant in the case of the Mierzanowice culture, Trzciniec culture and early phases of the Lusatian culture.

Key words: Neolithic; Bronze Age; Early Iron Age; Lesser Poland; salt production

Received: 24.03.2015; Revised: 5.07.2015; Revised: 13.07.2015; Accepted: 7.09.2015

INTRODUCTION

For a dozen of years or so, rescue excavations associated with the construction of the Kraków section of the A4 motorway have been carried out. The investigations provided an extremely numerous array of materials related to salt production carried out by prehistoric communities. The obtained materials partially fitted in with the scheme developed in the 1970s by A. Jodłowski (1971; 1976), whereas a part of them have opened brand new research perspectives.

One of the sites that delivered a large series of chronologically diversified materials related to salt production was Kraków-Bieżanów, Site No. 15 (Fig. 1). The site was located on the southern slope of the Vistula river valley. In terms of geomorphological division of southern Poland, this region belongs to the macroregion of the Sandomierz Basin and the region of the Wieliczka-Gdów Upland (Klimaszewski 1972, 90). An erosive landform of Bieżanów developed on the folded Miocene sediments, mostly on loams and Bogucice sands. The substratum consists of the Lower Tortonian Bogucice sands covered with the Quaternary deposits. The site is located on the northern slope and the top of the hill that constitutes a fragment of an erosion-denudation flattening with a relative height of 20–30 m above the bottom of the surrounding valleys. This flattening was shaped in the Pleistocene, on the plain formed due to an accumulation of kame sediments of the Kraków Glaciation (Kalicki, Przybyła 2011).

In the course of the archaeological excavations conducted in 1999-2008 by the Cracow Team for Archaeological Supervision of Motorway Construction, a total number of 1.572 non-portable features and ca. 250 thousands movable artefacts was discovered at the site covering an area of 9 ha[1]. They were ascribed to the Swiderian and Linear Pottery cultures, as well as the Pleszów-Modlnica and the Wyciąże-Złotniki groups of the Lengyel-Polgár complex, the Funnel Beaker, Baden, Corded Ware, Bell Beaker, Mierzanowice, Trzciniec, Lusatian and the Przeworsk cultures, and finally to the late Middle Ages and the Modern Times. Most of the above-listed cultural units left traces of their engagement in salt production. At the present stage of the research, the reconstruction of the entire salt production process employed by the prehistoric communities seems to be extremely difficult. However, the ceramic material and the salt production-related features revealed in the course of the investigations should be considered significant sources for further studies in this respect, and are thus worth mentioning.

SALT PRODUCTION-RELATED MATERIALS OF THE PLESZÓW-MODLNICA GROUP OF THE LENGYEL-POLGÁR COMPLEX

The Pleszów-Modlnica group (PMG) of the Lengyel-Polgár complex (LPC) represented the second, middle stage of the LPC development in western Lesser Poland (Kaczanowska 2006, 37, Fig. 1). In the region of Kraków a concentration of sites ascribed to this unit located in the area of Kraków-Nowa Huta was identified. Extremely numerous sites of the PMG were also encountered on

[1] Due to the size of the site, the authors decided not to include the site plan in the present paper.

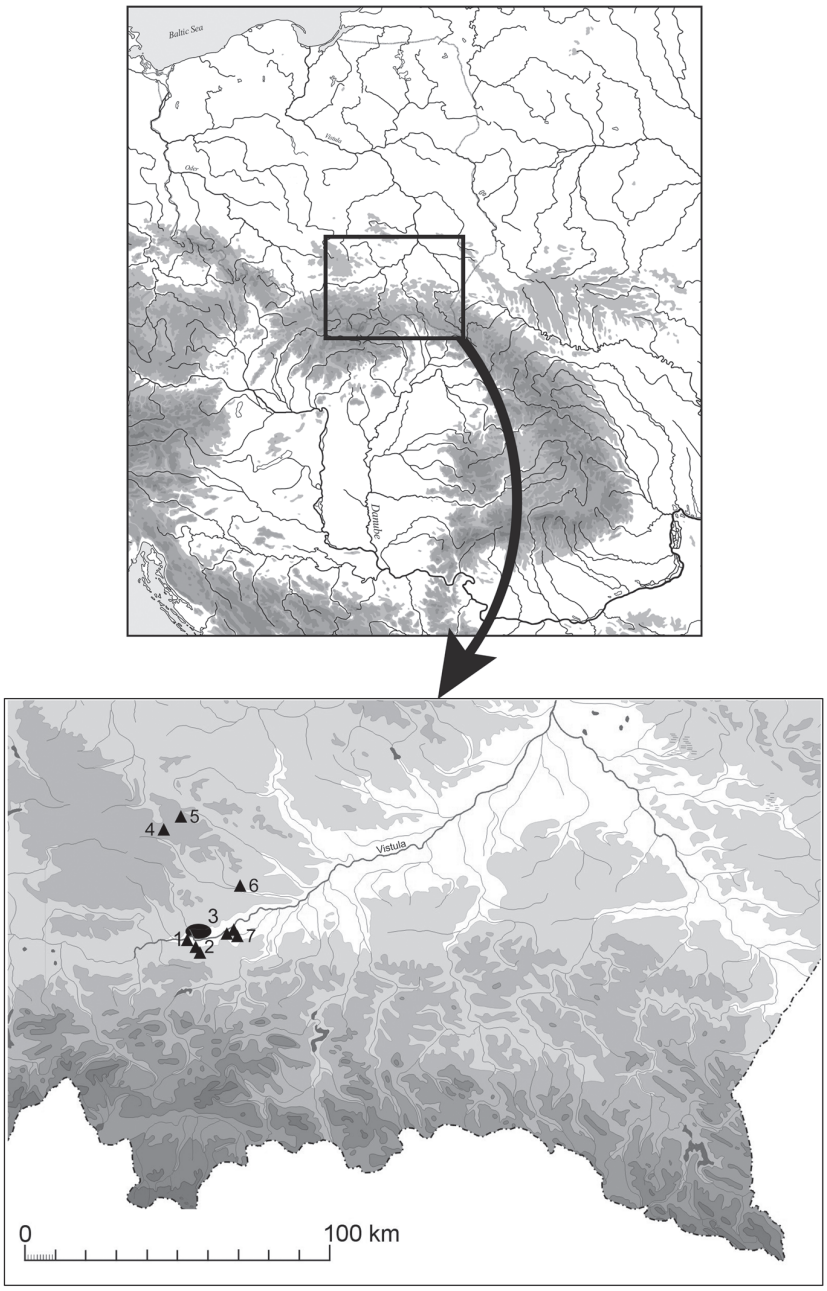

Fig. 1. Lesser Poland. Location of the sites mentioned in the text (p. — powiat; w. — województwo); drawn by M. Przybyła and I. Jordan.

1 — Kraków-Bieżanów, p. Kraków, w. małopolskie; 2 — sites in the region of Wieliczka, p. Wieliczka, w. małopolskie; 3 — sites in the region of Kraków-Nowa Huta; 4 — Miechów, p. Miechów, w. małopolskie; 5 — Bronocice, p. Pińczów, w. małopolskie; 6 — Gniazdowice, p. Proszowice, w. małopolskie; 7 — Łężkowice, Podłęże, Targowisko, Zakrzowiec and Zakrzów, p. Wieliczka, w. małopolskie.

the right bank of the Vistula river, in the region of Wieliczka (Grabowska, Zastawny 2011, Fig. 16).

Almost all of the prehistoric materials associated with the PMG were ceramic vessels. There were 181 fragments of pottery found at the site. A great majority of them (88 pcs.) came from vessels used for salt production. They constituted 48% of the entire ceramic inventory (Fig. 2:3–4) and formed a technologically homogenous group. They were made of clay containing large amount of sand and possibly, small-grained mineral admixture. The interior surface of the vessels was smooth, while the exterior one was rough. The pottery was mostly of brick-red or light grey colour, which might have been partially due to secondary charring of the specimens. The sherds were 6–8 mm thick. All of them came from one type of vessels: large, conical specimens with strongly widened, thickened rim specifically bent outward. The rim edges were smooth or corrugated. All of the analysed vessels were most likely equipped with handles modelled in the form of conical knobs bent upward, or short bands attached to the exterior surface, decorated with finger-tipping. The latter ones were placed a few centimetres below the rim. Basing on the analogues known from other sites, the vessels in question usually had pointed bottoms, though in some cases their bottoms were flat, with very small diameters. Their primary height and rim diameter reached up to 30–35 cm.

For many years, vessels of this type have been encountered at the PMG sites in the region of Kraków, especially at those linked with its older developmental phase. They were rather explicitly associated with the production of salt from brine springs (Burchard 1967, 8–9; Godłowska 1976, 24–25; Jodłowski 1976, 69, 93, Kaczanowska 2006, 45–46). For instance, a large series of salt production-related features and wide-mouthed vessels equipped with conical knobs were discovered in Barycz (Fig. 2:7–8; Szybowicz 1981, Fig. 4:2–23). Analogous vessels for salt production were also found in Wieliczka (Fraś, Pawlikowski 2007, Fig. 2:c,e), Wieliczka-Rożnowa (Kaczanowska 2006, 105), Lednica Górna (Fig. 2:12–13; see Fraś, Pawlikowski 2009, Fig. 4:a–d), Kraków-Nowa Huta-Pleszów (Fig. 2:10–11; see Kulczycka-Leciejewiczowa 1969, Pl. XIX:1; XX:11; XXIII:1; XXXVII:18; XXXVIII:9, 16; XXXI:9; XXXVII:17, 19, 21), Kraków-Nowa Huta-Cło (Kaczanowska 2006, 104) and Targowisko Wieliczka (Rook 1968, Pl. X:1, 3, 17). A great number of pottery of this type (Fig. 2:1–2) has recently been discovered in the course of the rescue excavations carried out on account of the motorway construction in Zakrzowiec (Fig. 2:1–2; Jarosz, Szczepanek, Wołoszyn 2012, 309–310, Fig. 6: 1, 3, 7–9, 11–12; 10: 1, 9).

The large, wide-mouthed specimens discussed here were not the only form of vessels used for salt production by the PMG community. There were also small, conical *briquetage* with pointed bottoms, made of clay with a great amount of sand admixture (Fig. 2:6). Both types of the vessels were encountered e.g. at

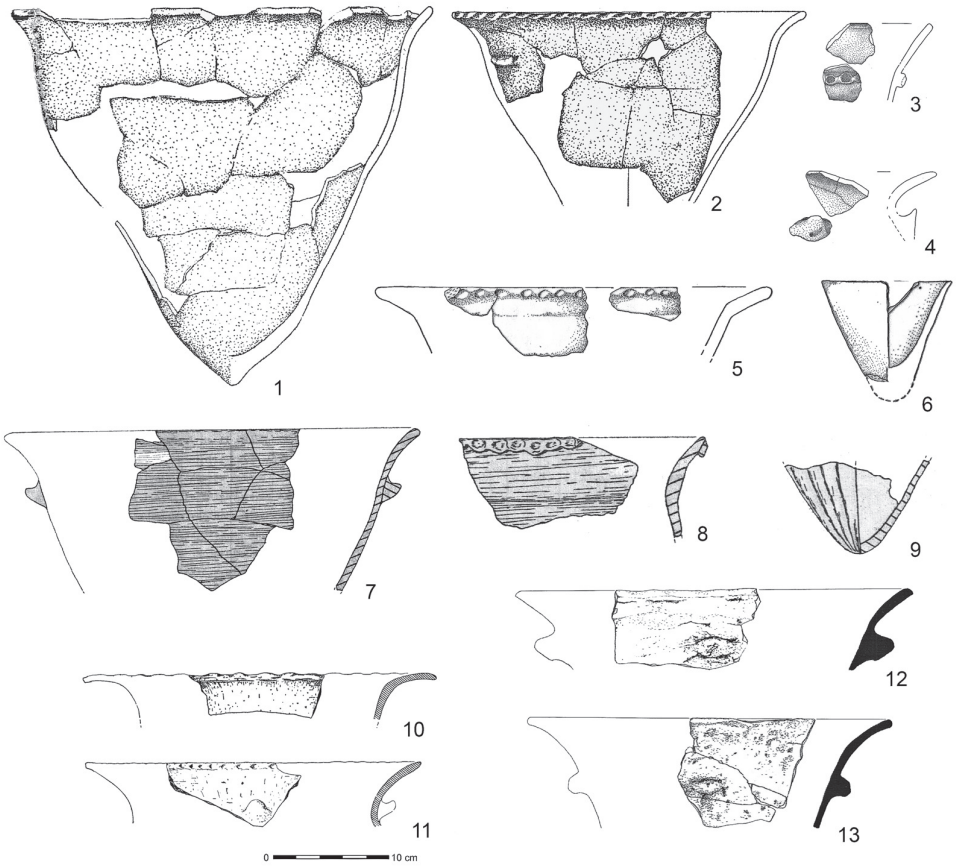

Fig. 2. Salt vessels of the Pleszów-Modlnica group of the Lengyel-Polgár complex (p. — powiat; w. — województwo); after P. Jarosz, A. Szczepanek, M. Wołoszyn (2012, Fig. 10: 1, 9), M. M. Przybyła (2012, Fig. 5:6, 6:8), A. Szybowicz (1981, Fig. 4:1, 15, 5:1), A. Kulczycka-Leciejewiczowa (1969, Pl. 37:17, 19) and J. M. Fraś, S. Pawlikowski (2009, Fig. 4:1,b); computer design M. M. Przybyła.

1–2 — Zakrzowiec, p. Wieliczka, w. małopolskie; 3–4 — Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 5–6 — Łężkowice, p. Wieliczka, w. małopolskie; 7–9 — Barycz, p. Wieliczka, w. małopolskie; 10–11 — Kraków-Nowa Huta-Pleszów, p. Kraków, w. małopolskie; 12–13 — Lednica Górna, p. Wieliczka, w. małopolskie.

the settlement in Łężkowice[2] (Fig. 2:5–6). In certain cases, when the ceramic material was strongly shredded, distinguishing small *briquetage* from bottom parts of wide-mouthed vessels was hindered. Among others, this applies to numerous pottery fragments discovered at the site in Barycz (Fig. 2:9).

[2] Unpublished materials from the excavations conducted by M. M. Przybyła.

SALT PRODUCTION-RELATED MATERIALS OF THE FUNNEL BEAKER CULTURE

The Funnel Beaker culture (FBC) is the Neolithic cultural unit most numerously represented at site No. 15 in Kraków-Bieżanów. The gathered materials may be linked with the classical stage of the FBC development in Lesser Poland, most likely, with its older period, corresponding with the Bronocice II phase (Kruk, Milisauskas 1983) and synchronised with the younger Wiórecka phase in Polish Lowlands (Włodarczak 2006, 31, 34). In the course of the excavations, 3,142 fragments of ceramic as well as flint and stone artefacts were collected. Moreover, 16 non-portable features associated with the FBC were discovered. With regard to the latter ones, oval-shaped, circular and rectangular (Fig. 3:22–23) hearths prevailed, with their fillings containing fragments of beakers for salt production. At the site in Bieżanów, relics of numerous water springs were found. They functioned in various periods of prehistory and, at least, two of them were used when the settlement was occupied by the FBC society. Particularly noteworthy is the water spring No. 1653. Around its northern part, there was accumulation of several hundred sherds of the FBC pottery, including numerous fragments of beakers for salt production. The ceramic material was scattered within five meters from the water source.

Fragments of beakers for salt production (*briquetage*) constituted a great part of the entire FBC ceramic material. All together, 780 fragments were found (21.8% of the entire ceramic inventory, or 50% if non-diagnostic fragments are disregarded). The beakers discussed here were high, conical in shape and wide-mouthed, with a height ranging from a dozen or so to more than 20 cm, a rim diameter between 8 cm and 14 cm and a bottom diameter ranging from 4 cm to 10 cm. With regard to all recognisable fragments of beakers, they had uneven exterior surfaces, wearing traces of being formedby hand, visible on both, walls and pedestals of the vessels. In many instances, they were also intentionally, vertically or obliquely finger-smeared. Their interior surfaces were usually smooth. The vessels in question were made of poorly mixed mass of clay with an admixture of medium-grained crushed ceramics. Sporadically, as temper the clay contained sand, crushed stones or, rarely, gravel.

The analysed beakers may be divided into the following types:

I — thick-walled beakers (10–12 mm) with strongly corrugated rims bent outward (Fig. 3:1);

II — thin-walled beakers (5–7 mm).

Within these types there were many variants. A great part of them were beakers without modelled elements. However, beakers fitted with modelled elements constituted a large and internally diversified group as well. This group included: beakers with a corrugated rim (Fig. 3:2), beakers with a corrugated rim and a band running around the vessel (Fig. 3:6), beakers with a smooth rim and a band running around the vessel (Fig. 3:5), beakers with a corrugated rim strongly bent outward and a knob placed below the rim (Fig. 3:4), beakers

with a thickened, corrugated rim, and finally beakers with a thickened, corrugated rim and a row of fingerprints below the rim (Fig. 3:3).

As it seems, all of the beakers had a more or less distinguished pedestals (Fig. 3:7–8).

The possibility of exploiting brine springs by the FBC communities in south-eastern Poland was first considered by B. Burchard (1967, 9–10). Whereas, M. Godłowska (1976, 30) reported an occurrence of the FBC pottery encountered at the settlements in Nowa Huta with strongly charred bottoms, containing Na and Na_2O in a much greater amount than usual. Another researcher, A. Pelisiak (2008, 55–57) pointed out the legible relationship between the expansion of the Neolithic settlements, including the FBC ones, and the distribution of brine springs over the area of the Polish and the Ukrainian Carpathian Mts. Among the published FBC materials from Nowa Huta, a great number of fragments of vessels for salt production may be distinguished. At site No. 17 in Kraków-Nowa Huta-Pleszów fragments of both, pedestals coming from beakers for salt production (Godłowska 1976, Pl. XVII:7; XXIII:10), as well as rims of thin-walled beakers without modelled elements (Godłowska 1976, Pl. XXIII:9) were found. Relatively numerous sherds of beakers for salt production are also known from site No. 62 in Kraków-Nowa Huta-Mogiła, dated to the Br II phase (Godłowska 1976, Pl. LXXI:5–7; Kluzik 2010, 12, 15, Pl. VII:7, 11; VIII:22; IX:33–35; XII:10; XIV:18, 30). Fragments of *briquetage* were discovered in Kraków-Prądnik Czerwony as well (Fig. 3:18; Rook, Nowak 1993, Fig. 9:g). In the recent years, very interesting materials have been revealed on account of the investigations carried out by the Cracow Saltworks Museum in Wieliczka. The excavation conducted at the FBC settlement at site No. 48 in Wieliczka yielded numerous fragments of vessels for salt production (Fraś, Pawlikowski 2009, 318). Among them, there were extensive sets of pedestals with distinguished bottoms (Fraś, Pawlikowski 2009, Fig. 5:o, p, r, s; 6:i), rims of thin-walled beakers without modelled elements (Fraś, Pawlikowski 2009, Fig. 6:e) and beakers with a crescent knob placed below the rim (Fraś, Pawlikowski 2009, Fig. 6:a, f). The latter ones were exceptionally large forms, resembling *briquetage* of the Pleszów-Modlnica group of the Lengyel-Polgár complex (Fig. 3:9–10). Judging by the drawings of pottery that accompanied the fragments of beakers for salt production, the settlement should be dated to the classical phase of the FBC development in western Lesser Poland.

Among the published materials from an upland settlement in Bronocice, situated in the middle Nidzica river basin, there are no beakers for salt production that could be linked with the Br I or Br II phases (except for one specimen, Fig. 3:14). In the Br III phase, there emerged vessels that could be determined as beakers without modelled elements, with trapezoid-shaped pedestal (Kruk, Milisauskas 1983, Fig. 5:30). Much more numerous beakers (Fig. 3:15–18) in highly diversified variants, come from the assemblages dated to the Br IV and V phases (Kruk, Milisauskas 1983, Fig. 6:33–34; 7:27; 18:4–5, 7, 9; 22: 8–9). However, it should be stressed that the materials

dated to these phases belonged to the Baden cultural complex, even though they derived from the FBC tradition (Kruk, Milisauskas 1983, 272). All the beakers for salt production from Bronocice were made of clay containing a great amount of crushed ceramics and stone temper. Their exterior surfaces were rough, of light brown or brick-red colour (technological group D; Kruk, Milisauskas 1983, 279–280).

In the Funnel Beaker-Baden environment in western Lesser Poland, apart from the above-mentioned beakers, another type of vessels for salt production could have been used. Most likely, it was a hemi-spherical bowl with a corrugated rim bent inward. These bowls were executed in a manner typical of *briquetage*, made of clay with an admixture of medium-grained chamotte. Both of their surfaces were uneven, roughly elaborated (Fig. 3:20–21). They were discovered among the materials collected from the surface of the settlement in Gniazdowice (Przybyła, Szczepanik, Podsiadło 2015, Fig. 13:11–12) and in the fills of the Funnel Beaker-Baden features at the settlement in Miechów[3]. At both of the above-mentioned sites, fragments of beakers similar to those from Bronocice were found as well (Fig. 3:19). A noteworthy fact is that some of the relatively numerous vessels for salt production encountered at settlements outside the Wieliczka-Gdów Upland, such as Bronocice, Gniazdowice and Miechów, have no exact analogues at the sites in the Wieliczka-Bochnia region. This may indicate an existence of the local production of salt, beyond the traditionally defined salt deposits area. This issue requires a thorough investigation, regarding the occurrence of potential brine springs within the Nida Basin.

SALT PRODUCTION-RELATED MATERIALS OF THE BADEN CULTURE

The Baden culture (BC) settlement encountered at site No. 15 in Kraków-Bieżanów may be linked, most possibly, with the classical or late phase of the BC development, which corresponds with dating of the Baden settlements (assemblages of the Mogiła type) in the Wieliczka-Bochnia region (Zastawny 2000, 30). At the site in question, the Baden culture was represented by 151 fragments of pottery and only two features. With regard to the non-portable objects, the first one may be a relic of a small hearth used for salt evaporation (Fig. 4:1). Its fill contained fragments of two beakers for salt production. Both of them were made of clay with small- and medium-grained chamotte temper (Fig. 4:2–3). Surfaces of the both vessels were uneven. Their primary colour was difficult to establish due to charring, which resulted in turning the colour to grey-white. Another specimen that could be linked with the Baden culture was a fragment of a pedestal with a distinguished bottom, coming from a *briquetage* (Fig. 4:4). Basing on the analogues known from other sites, it may be

[3] Materials from unpublished investigations conducted by A. Peschel, G. Pryc and A. Buszek.

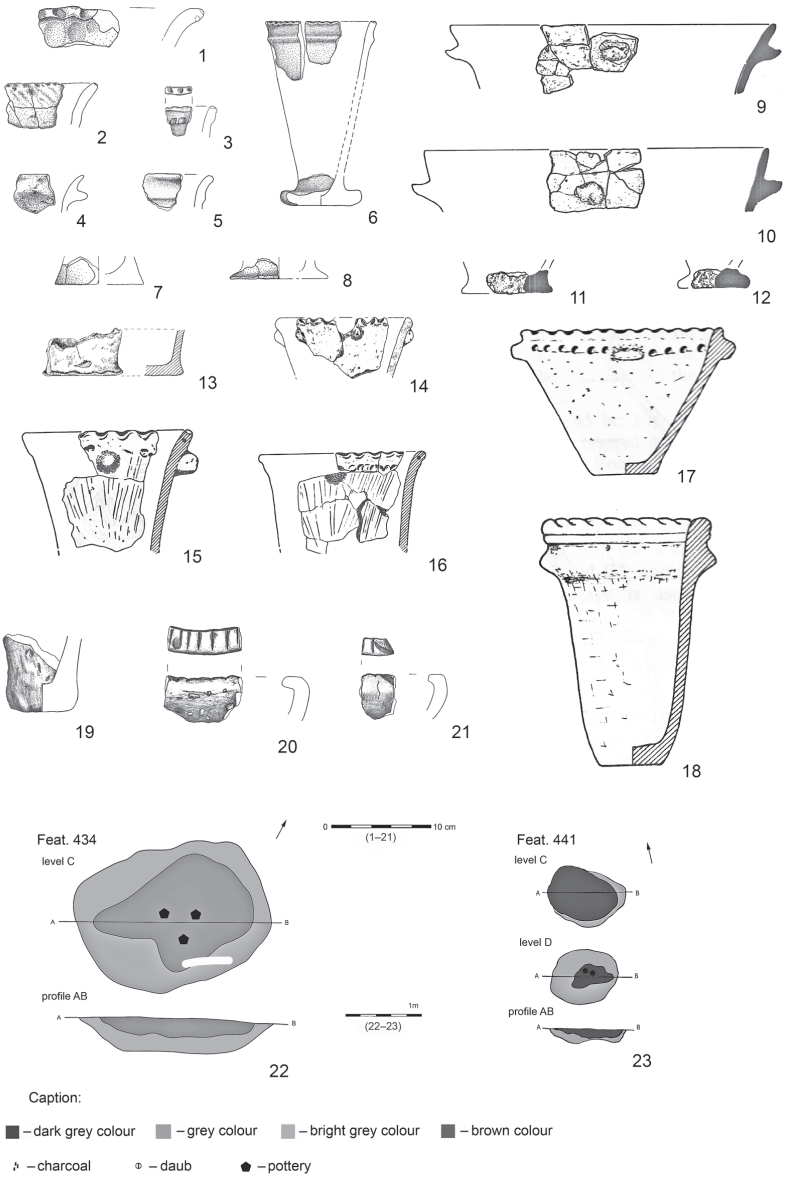

Fig. 3. Salt vessels of the Funnel Beaker culture (1–14) and the Funnel Beaker-Baden phase (15–21; p. — powiat; w. — województwo); after M. M. Przybyła (2012, Fig. 9:1, 10, 17:11, 20:2, 7, 9–10, 12); J. M. Fraś, S. Pawlikowski (2009, Fig. 5:p, s, 6:a, f), E. Rook, M. Nowak (1993, Fig. 9:g), J. Kruk, S. Milisauskas (1990, Fig. 10:1, 23:6, 9, 11–12) and M. M. Przybyła, A. Szczepanik, M. Podsiadło (2015, Fig. 13:11–13); computer design M. M. Przybyła.

1–8 — Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 9, 10, 11, 12 — Wieliczka p. Wieliczka, w. małopolskie; 13 — Kraków-Prądnik Czerwony, p. Kraków, w. małopolskie); 14–18 — Bronocice, p. Pińczów, w. małopolskie; 19–21 — Gniazdowice, p. Proszowice, w. małopolskie; 22–23 — salt production-related hearths of the Funnel Beaker culture from Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie.

assumed that the beakers had a form of tall, conical vessels, with a height ranging from a dozen or so to more than 20 cm and a bottom diameter of ca. 5–10 cm (Fig. 3:7–15). Fragments of similar beakers for salt production ascribed to the Baden culture were discovered at the settlement in Kraków-Nowa Huta-Branice (Fig. 4:10–12; Godłowska 1986, Pl. VIII:6–7) and Kraków-Nowa Huta-Pleszów (Fig. 4:5–9, 13; Rook 1971, Pl. V:5; IX:2; X:8; XVII:10; XVIII:5; XXVIII:2–3; XXX:1; XXXV:1; XXXIX:1, 7; XLI:5; LXII:1, 3).

The production of salt by the Baden communities in Lesser Poland is a fact widely accepted in the archaeological literature (Fries-Knoblach 2001, Pl. 6:1, Zastawny 2000, 28–29). Employing beakers for salt production by the BC societies in the region of Nowa Huta was first suggested by M. Godłowska (1976, 62). Evidence for salt production carried out by the Funnel Beaker-Baden communities was provided by a discovery of well-preserved beakers in assem-

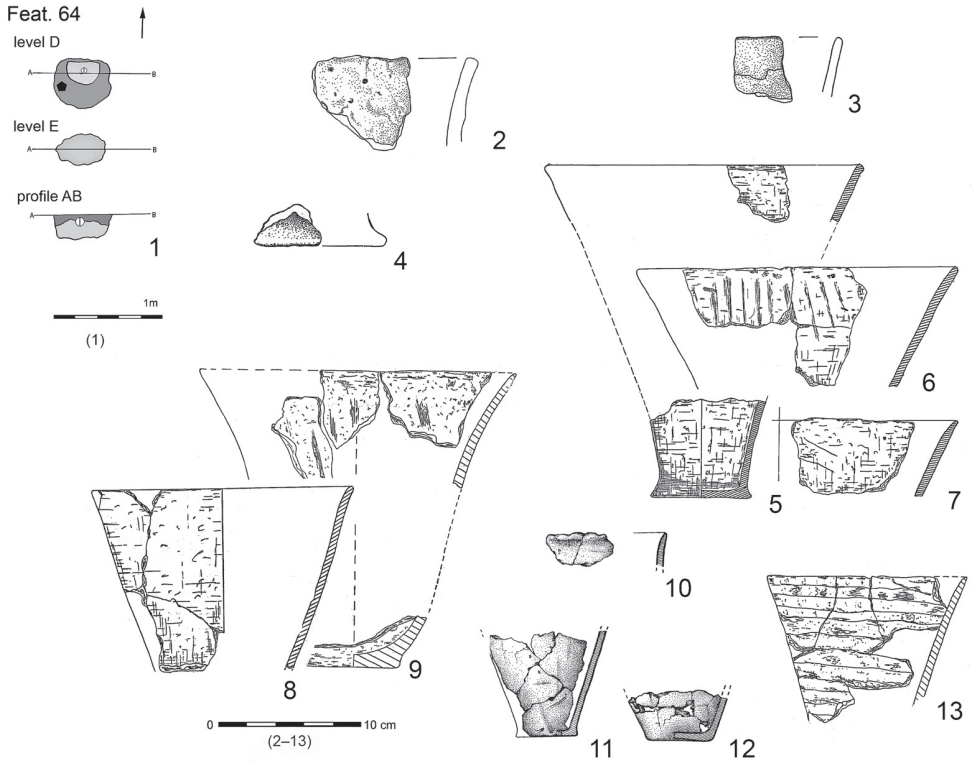

Fig. 4. Salt vessels (2–13) of the Funnel Baden culture and salt production-related hearth (1) of the Baden culture (p. — powiat; w. — województwo); after M. M. Przybyła (2012, Fig. 36:1–2, 38:1); E. Rook (1971, Pl. 37:2–3, 41:5, 12, 42:2, 5) and M. Godłowska (1986, Pl. 5:7, 10); computer design M. M. Przybyła.

1 — salt production-related hearth of the Baden culture from Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 2–4 — Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 5–9, 13 — Kraków-Nowa Huta-Pleszów, p. Kraków, w. małopolskie; 11–12 — Kraków-Nowa Huta-Branice, p. Kraków, w. małopolskie.

blages dated to the IV and V developmental phase of the settlement in Bronocice (Kruk, Milisauskas 1983, Fig. 6:33–34; 7:27; 16:4–9; 22:9). Moreover, vessels identical to the beakers of the classical BC phase were found at the site in Nowa Huta-Branice, within a feature ascribed to the Wyciąże group of the Polgár-Baden horizon (Godłowska 1986, 13, Pl. V:2, 6–7, 9–11). Taking into account resemblance in forms between the FBC beakers for salt production, the Funnel Beaker-Baden vessels and the Baden beakers collected from sites in the region of Kraków, an existence of the long-standing tradition of salt production, starting from the beginnings of the FBC development (Br I/II phase), through its younger phase (Br III), the Funnel Beaker-Baden phase (Br IV and V), the Wyciąże group of the Polgár-Baden horizon, until the classical and late phase of the BC development (Mogiła type and Zesławice-Pleszów group), must be considered a fact. In the developmental cycle discussed herein, similar vessels for salt production were used; moreover, the very same brine springs were uninterruptedly exploited. The possibility of salt production is also taken into account with regard to the Baden communities in their "homeland" in Hungary. In this case, there are suggestions referring to potential utilisation of absolutely different form of a vessel in a role of briquetage — a tub-shaped vessel (Tünde 2010, Fig. 5). The variability in forms of vessels for salt production known from Lesser Poland and Hungary may additionally support the hypothesis that the BC societies from the Kraków region cultivated the older FBC tradition of salt production.

SALT PRODUCTION-RELATED MATERIALS OF THE MIERZANOWICE CULTURE

The Mierzanowice culture (MC) of the Early Bronze Age was represented at the site in question by 25 non-portable features and 5,076 artefacts. Almost all of them should be associated with the Pleszów group dated to the late phase of the MC development (Kadrow, Machnik 1997, 121–131). Contrary to the above-mentioned Neolithic cultures, the existing publications disregarded the possibility of salt being produced by the communities of the Early and Older Bronze Age in western Lesser Poland. Only after the discoveries made in Kraków-Bieżanów, such a thesis could be put forth. The investigations also allowed to identify the form of a vessel for salt production – a hemi-spherical or conical bowl (Przybyła 2010b, 414–416). These forms were very typical of the Pleszów group of the MC (Kadrow, Machnik 1997, 122, Fig. 51:A–G), encountered only in western Lesser Poland. These bowls were the most frequent type of the MC vessels among those found at the site in Bieżanów (74% of the MC inventory). They were large, thin-walled specimens with a rim diameter ranging between 20 cm and 30 cm, and a height from 15 cm to 25 cm (Fig. 5:1–6). They often wore traces of secondary charring, which caused changing of their colour into red, white and violet. A great majority of them

had a gently roughened exterior surface, decorated with oblique or horizontal brush strokes (*Besenstrich*). The specimens in question usually had small holes pierced within a distance of 1.5–3 cm one to another, running around the vessel, ca. 1 cm below the rim edge.

In fact, within the environment of the Pleszów group of the MC, such bowls are known exclusively from the sites located in the region of Kraków. The most numerous series of this type of vessels (Fig. 5:19–10) was provided by the eponymous site in Kraków-Nowa Huta-Pleszów (Madej 1998, Fig. 3:2, 5, 11; Pl. III:1–2, 6, 11–12, 16, 19–20; XIV:9–26; XV: 10–11, 15–38).

A condiserable part of the features encountered at the site should be included in the category of hearths of various sorts. Among them there were small, close to oval-shaped (Fig. 5:7), circular or quadrangular hearths, with basin-shaped profiles, resembling the hearths for salt evaporation known from the Neolithic Age. Occurrence of large multipart hearths was a brand new cultural trait. At site No. 15 in Kraków-Bieżanów only one feature of this type, linked with the Mierzanowice culture, was discovered (Fig. 4:8). More of them are known from Kraków-Bieżanów, Site No. 34 (Przybyła 2010b) and Kokotów 18[4]. In the horizontal plan, the feature in question was a rectangle with dimensions of 4.25 × 2.5 m. Its profile had a shape of a shallow basin with a flat bottom. In the feature fill, there were two elongated layers of charred deposits with a width of 0.5–1 m, lying along the shorter sides of the hearth. In between there was a vast, inner pit.

As mentioned previously, the existing studies neglected the possibility of salt production in western Lesser Poland in the Early Bronze Age. Associating the above-described findings with the production of salt had not been possible until they were confronted with other discoveries from the region of the Carpathian Mts. Among the latter ones, the most important were the traces of obtaining salt by the MC communities in the territory of south-western Ukraine. Excavations at the site in Loyeva (Ukraine), revealed salt production-related hearths containing fragments of both bowls with smooth surfaces and those decorated with brush strokes (Fig. 6:1–2), displaying a striking resemblance to the "Pleszów" bowls (Krushel'nits'ka 2002, 144–151, Fig. 5–7). Whereas, the closest, in terms of geographical location and chronology, analogues for the bowls from Loyeva may be found in vessels (Fig. 6:3–5) known from sites in Romania (Petre-Govora 1988, Fig. 3:1–13; 4:1–9; 6:2, 7–8). Noteworthy is also the fact that very similar bowls (Fig. 6:6–8) were encountered at the salt production-related site in Băile Figa in Romania, within the layers dated to the early Bronze Age (Harding, Kavruk 2013, 122, Pl. 4:2,4–9). Determining the "Pleszów" bowls as salt vessels seems to be supported by the presence of little holes pierced around the vessels below their rims. In 2010, J. Górski, PhD and M. Przybyła performed a successful experimental extraction of salt

[4] Oral information provided by Jacek Górski, PhD, engaged in elaboration of the materials coming from the above-mentioned site.

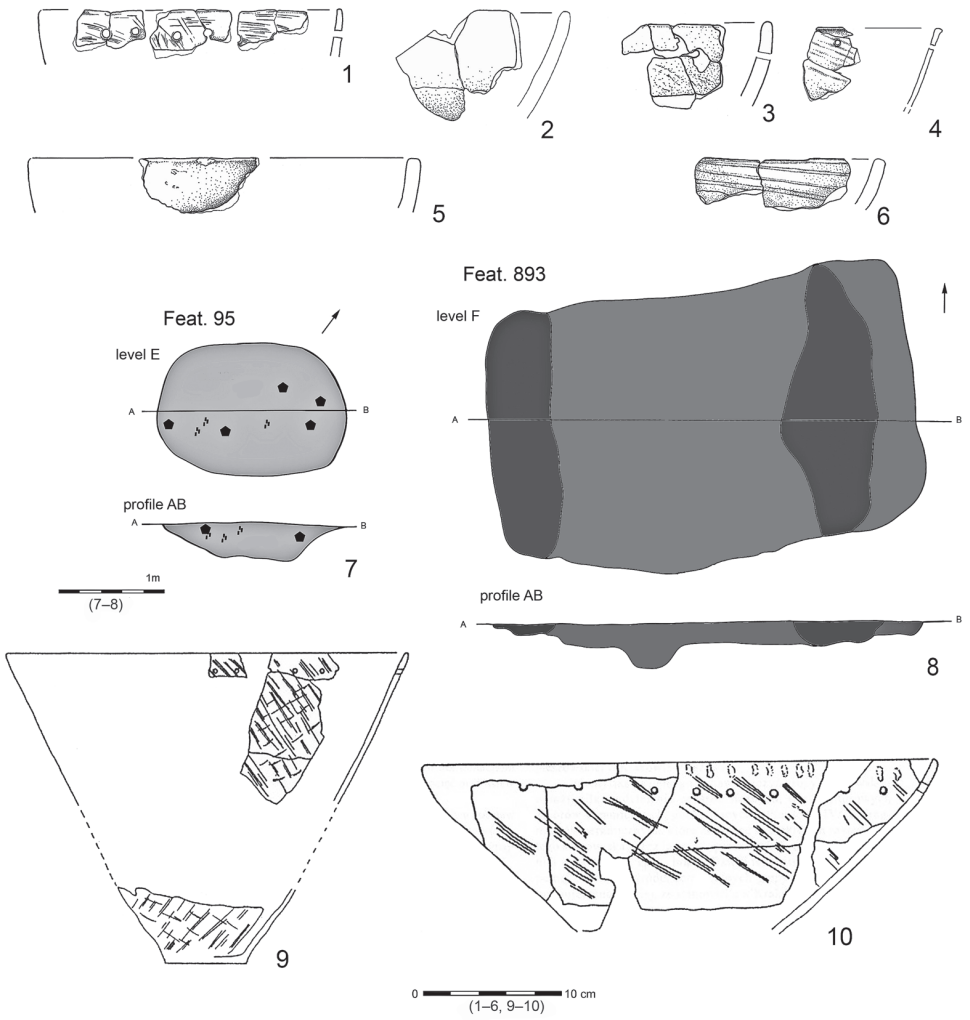

Fig. 5. Bowls of the Mierzanowice culture (1–6, 9) and salt production-related hearth (7–8) of the Mierzanowice culture (p. — powiat; w. — województwo); after M. M. Przybyła, M. Byrska-Fudali (2012, Fig. 1:1–2, 4, 3:4, 14:4, 6) and P. Madej (1998, Fig. 3:2, 5); computer design M. M. Przybyła.

1–6 — Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 9 — Kraków-Nowa Huta-Pleszów, p. Kraków, w. małopolskie; 7–8 — salt production-related hearths of the Mierzanowice culture from Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie.

with the use of replicas of the bowls in question, suspended over an open hearth by means of thongs and linen strings, attached to the holes pierced under the rims. The experiment was carried out in the Archaeological Museum of Kraków. It is possible that the holes in which thongs and strings were fixed also facilitated extracting brine directly from the spring. Such an application

of similar vessels was recorded in salt production process in the region of the Niger river (Gouletquer, Kleimann, Weller 1994, Fig. 96).

A crucial argument for interpreting the findings from Kraków-Bieżanów Site No. 15, dated to the late phase of the MC development, as relics of a production settlement is the fact that the assemblage in question represented an untypical set of ceramic forms, lacking characteristic vessels decorated with cord impressions — amphorae and cups — which were very typical of the Pleszów group (Kadrow, Machnik 1997, 126). The predominant forms encountered at the site were the "Pleszów" bowls (for salt production), pots and undecorated amphorae (brine containers, most probably). The "Pleszów" bowls were strongly fragmented and they usually wore traces of charring, just like most of the *briquetage* known from other prehistoric periods. Among the non-portable features revealed at the site in Bieżanów, hearths were prevailing, while no deep storage pits were recorded. The latter ones were very typical of the MC settlements on the left bank of the Vistula river.

SALT PRODUCTION-RELATED MATERIALS OF THE TRZCINIEC CULTURE

Until recently, the southern boundary of the Trzciniec culture extent had been precisely and indisputably determined in the existing literature. The boundary was marked by the Vistula river, flowing latitudinally in this particular area (Górski 1997, Fig. 1; Blajer 1985, 61–62). Only after discoveries made on account of the construction of the A4 motorway, a few untypical sites of the TC were revealed. They were situated on the right bank of the Vistula river, at the fringe of the Wieliczka-Gdów Upland. The TC settlement at site 15 in Kraków-Bieżanów was much more advanced than those typical of the above-discussed cultures. The investigations delivered nearly 140 thousands fragments of pottery and 159 non-portable features ascribed to this cultural unit. The TC settlement in Kraków-Bieżanów should be linked with the classical phase (assemblages of type A, acc. to J. Górski 1997) of the TC development in western Lesser Poland, i.e. the A2 and B periods of the Bronze Age (Górski 1997, 14). Among the ceramic forms, hemi-spherical and conical bowls were definitely prevailing (95% of the inventory; see Fig. 6:9–10, 12–13). The bowls were thick-walled, made of clay with a great amount of coarse-grained crushed granite or, sporadically, limestone temper. They belonged to the type 2.2, acc. to J. Górski (2007, Fig. 14). Similarly to the "Pleszew" bowls of the Mierzanowice culture, they are frequently fitted with little holes pierced below their rims.

Within the group of non-portable features, hearths for salt evaporation were predominant. A great majority of them were small, quadrangular (Fig. 6:15–16), oval-shaped and circular features. Apart from them, there were also multipart hearths (nine features of this type were discovered), sharing the characteristics with the analogous MC features (Fig. 6:17). Moreover, relics of two brine springs

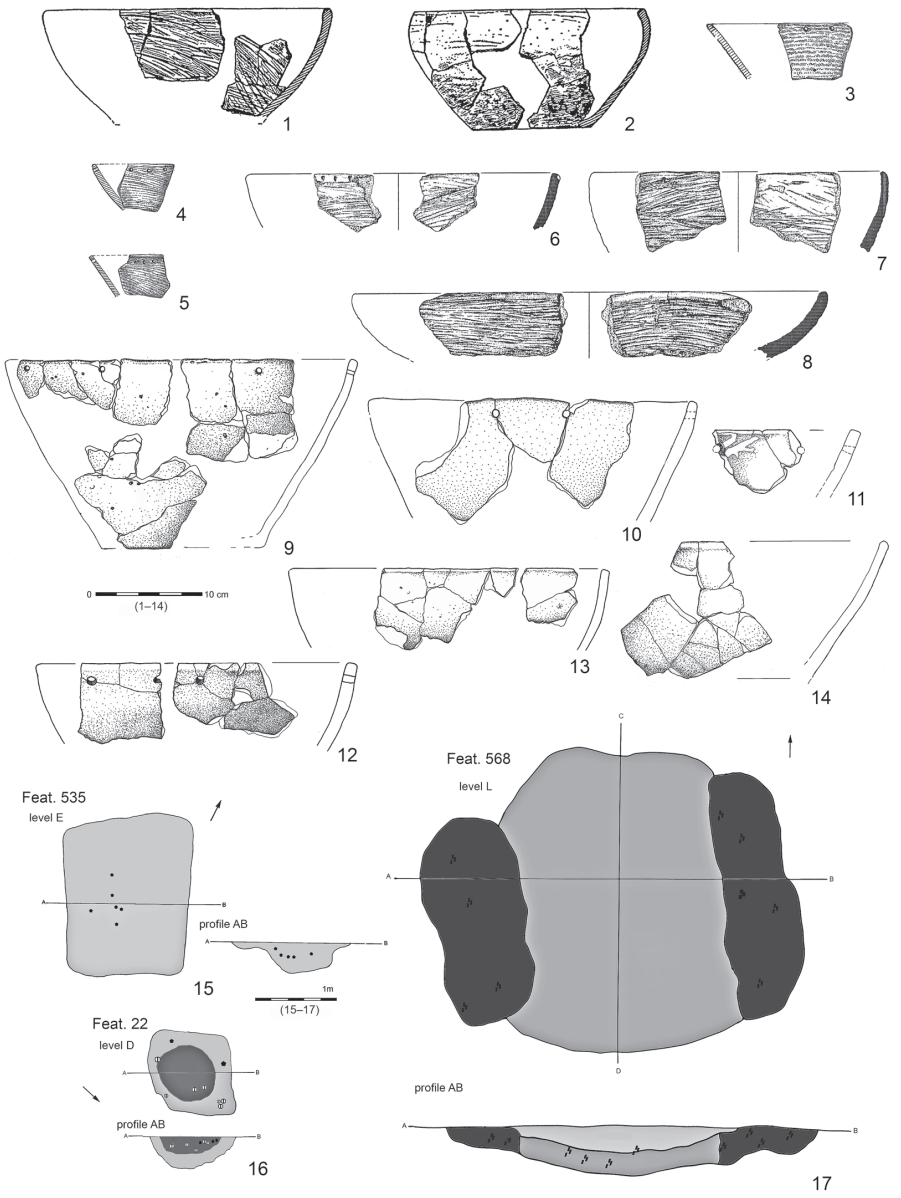

Fig. 6. Bowls of the Early Bronze Age (1–8), of the Trzciniec culture (9–14) and salt production-related hearths of the Trzciniec culture (16–17); after L. Krushel'nits'ka (2002, Fig. 7), G. Petre-Govora (1988, Fig. 3–4), A. Harding, Kavruk (2013, Pl. 4:4–5, 9), M. M. Przybyła, M. Byrska-Fudali (2012, Fig. 38:1, 5, 10, 60:3, 82:6) and M.M. Przybyła, B. Chudzińska (2009, Fig. 21:2, 7).

1–2 — Loyeva, Ivano-Frankivsk oblast, Ukraine; 3–5 — Zdub-Ocnele Mari județul Valcea, Romania; 6–8 — Băile Figa, județul Bistrița-Năsăud, Romania; 9–10, 12–13 — Kraków-Bieżanów, site No. 15, powiat Kraków, województwo małopolskie; 11, 14 — Zakrzów, p. Wieliczka, województwo małopolskie; 16–17 — Kraków-Bieżanów, site 15, p. Kraków, województwo małopolskie.

were identified at the site. The period of their functioning and exploitation was contemporaneous to the existence of the TC settlement.

An extraordinary predominance of bowls within the entire ceramic inventory from the site in Bieżanów requires explanation. This predominance of non-profiled bowls would not seem so surprising if they were considered vessels for salt production — *briquetage*. Salt vessels of the shape of a bowl were used by various prehistoric communities (Przybyła 2010b, 407–408). This thesis is also supported by the state of preservation of bowls that were found in Bieżanów. They were strongly fragmented and their fragments were often charred. Charring caused changing of their colour into red, white and violet, which was a typical feature of briquetage. Determining the bowls in question as vessels for salt production would allow to explain the untypical nature of site No. 15 in Bieżanów, where hearths were the prevailing features, there was no typical storage pits and a number of artefacts found within a cultural layer was disproportionately large when compared with a number of the features discovered. Non-profiled bowls were encountered within the entire range of the Trzciniec culture, though their share in the ceramic inventory was usually very low. Most likely, they were adapted by the TC communities from the region of Kraków as vessels for salt production, instead of designing a special form for this purpose. As far as is known, the only site with an inventory structure resembling the one from Bieżanów (48% of non-profiled bowls) is a production settlement at site 1 in Zakrzów (Fig. 6:11, 14; Przybyła 2010a).

Recently, mutual similarity between the bowls of the Pleszów group of the MC and the one-piece bowls of the TC have been reported in the related literature, suggesting that they might have been the very same element borrowed by the TC communities from the MC environment (Górski, Kadrow 1996, 18). The "Pleszów" bowls of the MC occurred almost exclusively at the sites in the region of Kraków. While the one-piece bowls of the TC were most numerous at the sites in the area of Kraków-Nowa Huta (Górski 1997, 11) and the above-mentioned sites on the right bank of the Vistula river. Thus, a thesis may be proposed that the technology of salt production in western Lesser Poland was borrowed by the TC communities from the preceding MC societies. What is interesting, is that similar bowls were found in hearths used for salt evaporation at the site in Loyeva, in Ukraine, in the context of the Komarov culture, which is related to the Trzciniec culture (Krushel'nits'ka 2002, 145–154). Numerous traces of producing salt by the communities of the Trzcinec-Komarov complex are known from the sites of the Komarov-Costişa culture in the territory of Romania (Dumitroaia 2000, 174–188, Fig. 95–103; Munteanu *et al.* 2007, 67).

SALT PRODUCTION-RELATED MATERIALS OF THE LUSATIAN CULTURE

The Lusatian culture (LC) settlement was of slightly different nature than the ones of the previously described units. It was more stable. Apart from the production-related features, there were also dwellings, storage pits and even a circular palisade. 318 non-portable features and 67 thousands movable artefacts may be linked with the Lusatian culture. The *briquetage* constituted 44% of the total ceramic inventory of the LC.

The vessels for salt production discovered at site No. 15 in Kraków-Bieżanów represented forms diversified in terms of their morphology, technology and chronology.

Taking into account the technology of preparing the clay body and the morphology of vessels, they may be divided into three major types, internally differentiated.

Type I — thin-walled, chalice-shaped, small beakers (Fig. 7:23–25). These were thin-walled vessels, with wall thickness ranging from 0.3 cm to 0.5 cm. They had a form of a slender, conical beaker on a short, usually widening pedestals. Their diameters ranged from 2.5 cm to 11 cm and the height between 6 cm and 12 cm. The vessels in question were encountered in two basic subtypes: less numerous ones were made of clay with a great amount of sand temper; more frequent ones were bigger and more robust, made of clay body containing a lot of medium-grained chamotte. They had pedestals shaped in various manners; their rims were smooth or corrugated.

Type II — thick-walled, conical beakers (Fig. 7:9–11). These were relatively thick-walled vessels, with wall thickness ranging from 0.6 cm to 1 cm. They had a form of a conical or pot-shaped beaker without a pedestal, with a distinguished bottom. Their height ranged from 20 cm to 30 cm, so did their rim diameter. They were made of clay with an admixture of medium-grained chamotte. Their surfaces were usually roughly finished, less frequently smoothened; they sometimes wore traces of finger-smearing. They had smooth or, less commonly, corrugated rims.

Type III — hemi-spherical bowls (Fig. 5:1–8). These were wide-mouthed, medium- and thick-walled vessels. They were made of clay with a great amount of small-grained mineral temper. Their surfaces were grey-brown, smooth or rough. They were 12–15 cm high, with a diameter ranging from 25 cm to 33 cm. Several variants of these vessels were recorded. Among them, there were specimens with smooth or corrugated rims and bowls with rims slightly bent inward.

The beakers of type I represent the most classical type of the LC briquetage containers typical of western Lesser Poland, where, at the end of the Bronze Age and the beginning of the Early Iron Age, a great boost in salt exploitation by the LC communities was recorded (Jodłowski 1976, 58–60). A great number of findings of chalice-shaped, small beakers were yielded by

sites from the region of Wieliczka (Fraś, Pawlikowski 2007, 305, Fig. 5; 2009, 311, Fig. 2:d–i). Less numerous specimens of this type are also known from sites in Nowa Huta, such as Kraków-Mogiła (Bazielich 1993, 123). An enormous quantity of small beakers, representing practically all of the variants encountered at site No. 15 in Kraków-Bieżanów (Fig. 7:18–21; Kadrow 2003, Fig. 14–18), was discovered, in the course of widespread excavations, at a vast settlement of the Lusatian culture in Kraków-Bieżanów, site No. 27 and Kraków-Rżąka, site No. 1, dated to the EB V period (Pieróg 2003, 58). Though, at this site the only temper added to the clay body was sand and, very rarely, small-grained mineral material (Pieróg 2003, 217–218). The "sand-based" technology was employed for production of chalice-shaped, small beakers coming from the LC assemblages dated to the Hallstatt C and D period in Podłęże (Dzięgielewski, Szczerba, Chudzińska 2011, 328–329, Fig. 12:e). Whereas, identical forms of small beakers, found at this site in the context of the Pomeranian culture from the Early La Tčne period, were made of clay with an admixture of chamotte (Fig. 7:28–30; Dzięgielewski, Szczerba, Chudzińska 2011, 335, Fig. 15:v–y), like the great majority of vessels from site No. 15 in Kraków-Bieżanów. At the LC sites 1 and 2 in Zakrzów, dated to the HaD period, almost all of the beakers for salt production (Fig. 7:26–27) were made of clay containing an admixture of sand (Przybyła, Chudzińska 2009, 23; Przybyła, Chudzińska, Trela-Kieferling 2009, 26).

With regard to the large vessels for salt production of type II, determining their chronology at site No. 15 in Kraków-Bieżanów is somehow controversial, since they exclusively occurred within a cultural layer, though in great number. However, the analysis of planigraphy clearly indicated their coexistence with artefacts dated to the early phase of the Lusatian culture (EB III).

Analogous vessels were discovered within a feature containing bronze artefacts dated to the beginning of the third period of the Bronze Age, at site No. 104 in Wieliczka (Fraś, Reguła 2001, 324, Fig. 2:b–f). Similar beakers (Fig. 7:12–15), dated to the EB III and IV period, were also found at site No. 112 in Wieliczka (Fraś, Pawlikowski 2007, 305–309, Fig. 6:a–j; 2009, Fig. 2:j–n). Their emergence was a kind of a technological breakthrough that followed a period when bowl-shaped vessels for salt production were used by local communities of the Mierzanowice, Trzciniec and early phase of the Lusatian cultures (a bowl of type III). At the present state of research, it is difficult to identify the sources of potential inspiration for switching to large, conical beakers for salt production of type II. A noteworthy fact is that similar forms also occurred in the context of the Gava-Holihrady culture, close to the LC in terms of chronology, at the site in Tekutcha, in Ukraine (Fig. 7:16–17). Most likely, they were used as vessels for salt production (Krushel'nits'ka 1993, 88–90, Fig. 43). Characteristically, this is another case, in which a potential connection between the Wieliczka-Bochnia salt production tradition and the one cultivated in western Ukraine may be indicated.

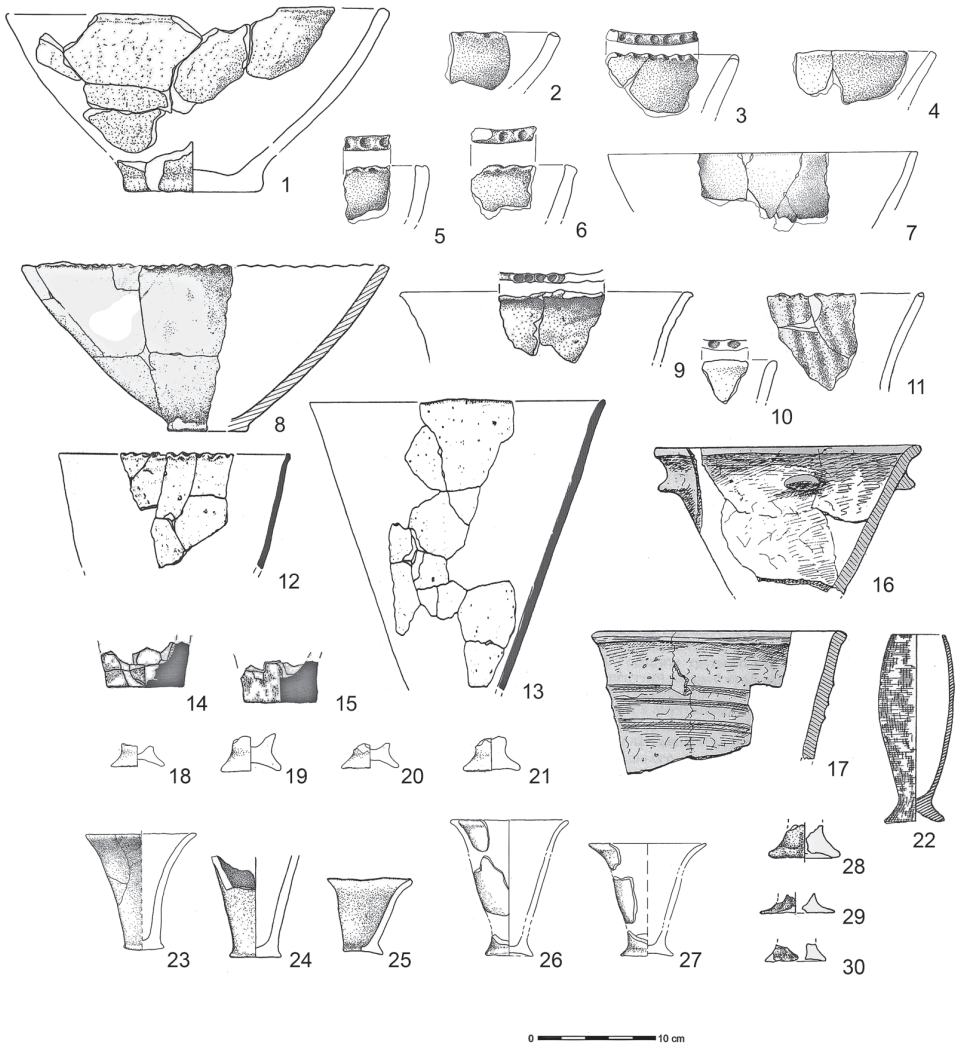

Fig. 7. Salt vessels of the Lusatian culture dated to the Bronze Age III and IV Periods (1–7, 9–15), conical vessels of the Gava-Holihrady culture (14–15), chalice-shaped vessels of the Lusatian culture dated to the Bronze Age V — HaD Period (16–25; p. — powiat; w. — województwo); after M. M. Przybyła, M. Byrska-Fudali (2012, Fig. 352:6, 367:2, 467:1–3, 470:1–2, 475:3–5), A. Rachwaniec (1985, Pl. 6:1), J. Fraś, A. Reguła (2001, Fig. 2:b, e), J. M. Fraś, S. Pawlikowski (2007, Fig. 6:i, h); L. Krushel'nits'ka (1993, Fig. 43), S. Kadrow (2003, Fig. 14–18), A. Szybowicz (1981, Fig. 7:i), M. M. Przybyła, M. Byrska-Fudali (2012, Fig. 388:2–3; 359:1), M. M. Przybyła, B. Chudzińska (2009, Fig. 16:1, 4) and K. Dzięgielewski, R. Szczerba, B. Chudzińska (2011, Fig. 12:e); computer design M. M. Przybyła.

1–7, 9–11 — Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 8 — Kraków-Nowa Huta-Mogiła, p. Kraków, w. małopolskie; 12–15 — Wieliczka, p. Wieliczka, w. małopolskie; 14–15 — Tekutcha, Ivano-Frankivsk oblast, Ukraine; 16–19 — Kraków-Bieżanów, site No. 27, p. Kraków, w. małopolskie; 20 — Barycz, p. Wieliczka, w. małopolskie; 21–23 — Kraków-Bieżanów, site No. 15, p. Kraków, w. małopolskie; 24–25 — Zakrzów, p. Wieliczka, w. małopolskie.

The most troublesome is the issue of bowls of type III. Relatively numerous fragments of bowls of this type wore traces of fire activity. Massive, hemispherical bowls made of clay with a great amount of crushed mineral temper, in particular those with corrugated rims, were endemic forms. Apart from the artefacts collected at site No. 15 in Kraków-Bieżanów, individual specimens of this sort were also recorded at settlements in Nowa Huta, such as Kraków-Nowa Huta-Mogiła-Kopiec Wandy (Fig. 7:8; see Rachwaniec 1985, Pl. VI:1), where they occurred in the context of the oldest phase of the Lusatian culture. At this point it should be stressed that handleless, hemi-spherical bowls are generally not encountered in assemblages of the early phase of the LC (Gedl 1962, 36). Whereas, at site No. 15 in Bieżanów they constituted the most numerous group of the early Lusatian pottery. As it was previously mentioned while describing the salt production tradition of the Mierzanowice culture, a form of a bowl was gladly used for salt production in various territories and chronological periods. Moreover, finishing hemi-spherical bowls of type III with corrugated rims does not appear to be accidental. Such a manner of shaping rims is very common among the vessels for salt production, e.g. briquetage containers of the Lengyel, Funnel Beaker and younger phases of the Lusatian cultures found at the site in question, while it is hardly ever met on bowls of the early phase of the LC from other sites.

The Lusatian communities used the types of hearths known from the early and older Bronze Age. Among them, there were small, oval-shaped, circular and quadrangular hearths (Fig. 8:1–2), as well as twenty large, multipart ones (Fig. 8:3). With regard to the both types of hearths, there were features associated with the early phase of the LC (EB III), classical phase of the Upper Silesia-Lesser Poland group (USLPG) of the LC (EB V — HaC) and the late phase (HaD — LT). In addition, a single relic of a brine spring with fragments of pottery for salt production in its fill was discovered.

Summing up, the settling of the site in question by the LC community took place during the third period of the Bronze Age. That was the time of migration of human groups from the territory of Silesia to western Lesser Poland (Gedl 1982, 21 – Key words 22). In this period, the production of salt, using local brine springs available at the site, was commenced. The beakers of type II and bowls of type III are the remains of that activity. A resemblance between the LC bowls of type III and one-piece bowls of the Trzciniec culture is worth particular emphasis. As it seems, the LC newcomers took over the saliferous lands of Bieżanów altogether with the tradition and technology of salt production developed by the Trzciniec community, or in fact, by the older one of the Mierzanowice culture, based on constructing multipart hearths and employing hemi-spherical bowls for salt production. Possibly, the bowls of type III were utilised for a short period of time, which is supported by the emergence of highly specialised beakers for salt production of type II, as early as in the EB III period.

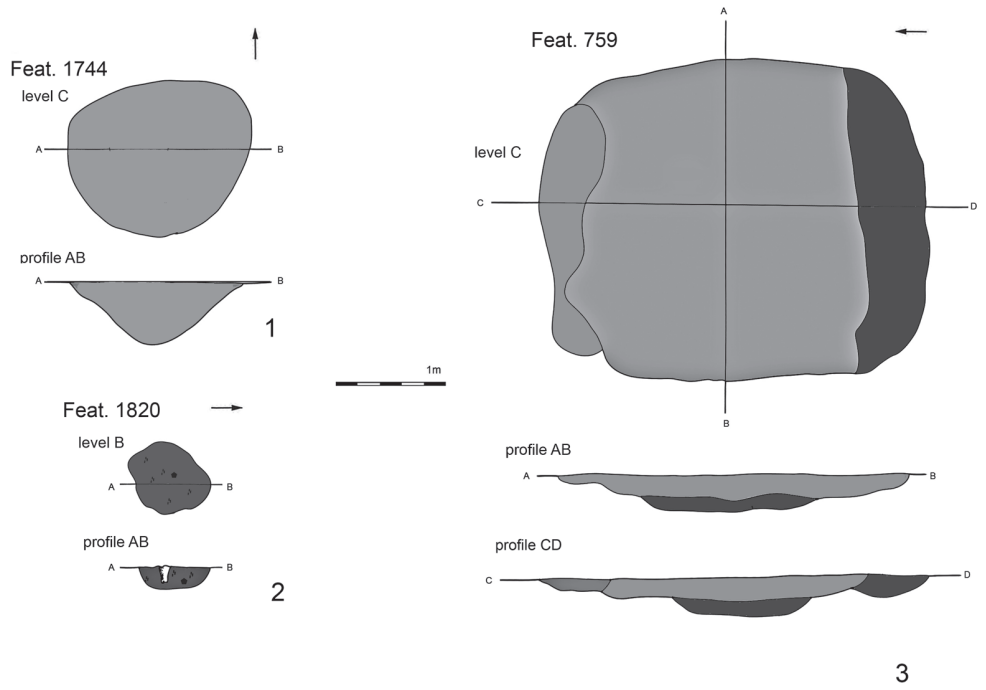

Fig. 8. Salt production-related hearths of the Lusatian culture from Kraków-Bieżanów, site No. 15, powiat Kraków, województwo małopolskie; drawn by M. Podsiadło.

At this moment, it is difficult to identify the inspiration that led to this form of a briquetage container. It is highly probable that the vessel in question was a domestic form developed locally in the region of Kraków. Though, it cannot be excluded that once again it was an effect of influences coming from western Ukraine. Utilisation of beakers of type II was continued in the fourth period of the Bronze Age. The end of the EB IV and beginning of V periods was the time when significant changes in settlement pattern took place, which resulted in the emergence of the Upper Silesia-Lesser Poland group (USLPG) of the LC (Gedl 1982, 25–26). In the youngest period of the Bronze Age, in the region of Kraków, including site No. 15 in Kraków-Bieżanów, new briquetage containers appeared in the form of chalice-shaped, small beakers (type I). These forms have analogues in the area of Central Europe, starting from the younger period of the Bronze Age until the early La Tène period (Matthias 1961, 119, 185, Fig. 2, 4–5, 8). During the Hallstatt C and D periods the production of salt significantly increased. Obviously, the decline of the Lusatian settlement in Kraków-Bieżanów put an end to the salt production at this site.

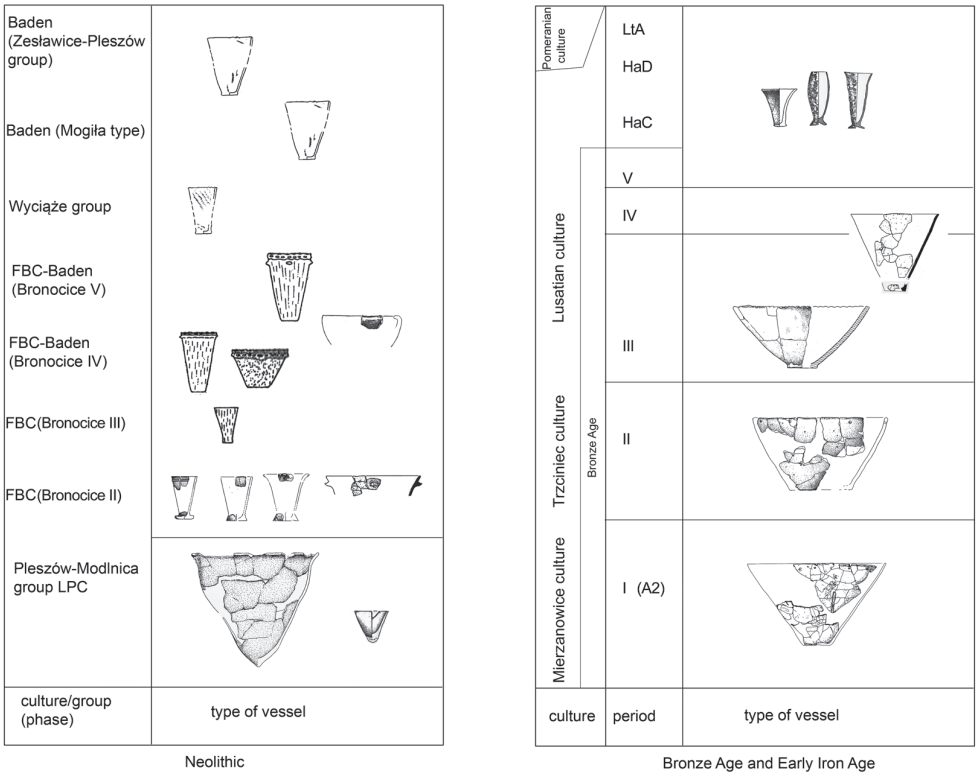

Fig. 9. Comparison of forms of vessels used for salt production in western Lesser Poland in the Neolithic, Bronze and the Early Iron Age; computer design M. M. Przybyła.

CONCLUSIONS

For all human societies, the prehistoric ones in particular, exploitation of salt has always been an important branch of economy that could not be overestimated. Its impact on the economic and civilisational advancement of human groups engaged in this activity was great (Harding 2013, 109–110, 121). As it seems, the production of salt in western Lesser Poland enhanced long-distance transcultural contacts, which is true for at least several chronological periods. In particular, this applies to the older period of the Bronze Age, when the local TC communities owned an exceptionally large quantity of artefacts of the Transcarpathian provenance (Górski 1997, 23–27). At least one of the reasons for the expansion of societies of the Silesian group of the LC and then, those of the La Tène culture, could have been their eagerness to seize the local brine springs. It cannot be excluded that the occurrence of brine springs influenced the development in western Lesser Poland of the only enclave of the Baden settlement in Poland.

Strikingly, despite the sandy substratum of site No. 15 in Kraków-Bieżanów, unattractive from the farming perspective, there were discovered relics of settlements representing almost every prehistoric culture that developed in western Lesser Poland, starting from the Early Neolithic Age (Linear Pottery culture) until the Hallstatt period. Among them, there were settlement materials of the Corded Ware and Bell Beaker cultures, sporadically encountered at other sites. The most obvious explanation of their occurrence in Kraków-Bieżanów is, in fact, the interest in local brine springs. Moreover, the presence of very abundant Late Palaeolithic materials (Stefański 2011) might be caused by the very same reason. Large series of the Late Palaeolithic and Mesolithic artefacts were also recorded at other sandy sites associated with salt production, e.g. in Zakrzów (Klimek, Peschel 2009).

The recently discovered salt production-related materials allowed to fill-up gaps in our knowledge of this aspect of prehistoric economy, particularly in the younger periods of the Neolithic and older phases of the Bronze Age. However, there are still many questions that have not been answered as yet. For instance, the issue of salt production by communities of the Linear Pottery culture remains entirely unrecognised. This concept seems likely, especially if we consider that the oldest traces of salt production in the region of the Carpathians are known from the territory of north-eastern Romania, and are dated to the period of 6050–5500 BC, i.e. preceding the Linear Pottery culture development (Weller, Dumitroaia 2005)

The highly developed tradition of salt production by the Pleszów-Modlnica group of the LPC lacks its genesis. There are no published materials referring to the salt production by the youngest units of the Lengyel-Polgár complex. Finally, there are many unsettled matters concerning the salt production in the La Tène and the Roman periods. It seems, that the quantity of data obtained from various sites, not only those revealed by the motorway construction-related excavations, is sufficient to launch detailed studies covering spatial analyses of sites involved in salt production, functioning of brine springs, reconstruction of full salt production processes in different chronological periods, as well as social and economical aspects associated with salt production. Unfortunately, an extremely abundant material collected in the course of the field research has not been published in its great majority, which hinders its appropriate utilisation.

REFERENCES

Abbreviations

KZdBA unpublished, typescript of the study is kept in the archives of KZdBA (Krakowski Zespół do Badań Autostrad sp.j., Kraków//Krakow Motorway Exploration Team, Registered partnership, Krakow).

SMDŻSP Studia i materiały do dziejów żup solnych w Polsce, Wieliczka.

Studies

Bazielich M.
1993 *Osada kultury łużyckiej w Nowej Hucie-Mogile na stan. 62. Część II*, Mat. Arch. NH 16, p. 103–140.
Blajer W.
1985 *Stan badań nad południowym zasięgiem kultury trzcinieckiej*, AAC 24, p. 61–88.
Burchard B.
1967 *Czy w neolicie eksploatowano solanki na Podkarpaciu Polskim?,* AAC 9:2, p. 5–10.
Dumitroaia G.
2000 *Comunităţi preistorice din nord-estul României. De la cultura Cucuteni până în bronzul mijlociu*, Biblioteca Memoria Antiquitatis 7, Piatra-Neamţ (Editura Constantin Matasă).
Dzięgielewski K., Szczerba R., Chudzińska B.
2011 *Osadnictwo z wczesnej epoki brązu, okresu halsztackiego i starszego okresu przedrzymskiego oraz ślady działalności człowieka w czasach średniowiecznych i nowożytnych na stanowisku 17 w Podłężu, pow. wielicki*, [in:] S. Kadrow (ed.), *Raport 2005–2006*, Warszawa (Narodowy Instytut Dziedzictwa), p. 315–348.
Fraś J. M., Reguła K.
2001 *Badania archeologiczne prowadzone przez Muzeum Żup Krakowskich Wieliczka w latach 1997–1998*, SMDŻSP 21, p. 321–336.
Fraś J. M., Reguła K.
2003 *Badania archeologiczne prowadzone przez Muzeum Żup Krakowskich w Wieliczce w latach 2001–2002,* SMDŻSP 23, p. 225–245.
Fraś J. M., Pawlikowski S.
2007 *Badania archeologiczne prowadzone przez Muzeum Żup Krakowskich w Wieliczce w roku 2005*, SMDŻSP 25, p. 299–310.
Fraś J. M., Pawlikowski S.
2009 *Badania archeologiczne prowadzone przez Muzeum Żup Krakowskich w Wieliczce w latach 2006–2007*, SMDŻSP 26, p. 305–321.
Fries-Knoblach J.
2001 *Gerätschaften, Verfahren und Bedeutung der eisenzeitlichen Salzsiederei in Mittel- und Nordwesteurope*, Leipziger Forschungen zur Ur- und Frühgeschichtlichen Archäologie 2, Leipzig (Professor für Ur und Frühgeschichte der Universität Leipzig).
Gedl M.
1962 *Kultura łużycka na Górnym Śląsku*, Wrocław–Warszawa–Kraków (Zakład Narodowy imienia Ossolińskich, wydawnictwo Polskiej Akademii Nauk).
Gedl M.
1982 *Periodyzacja i chronologia kultury łużyckiej w zachodniej Małopolsce*, [in:] M. Gedl (ed.), *Południowa strefa kultury łużyckiej i powiązania tej kultury z południem: materiały z konferencji, która odbyła się w Krakowie, Nowej Hucie i Nowym Sączu w dniach 11 do 14 IV 1978 r.*, Kraków–Przemyśl (Instytut Archeologii Uniwersytetu Jagiellońskiego w Krakowie, Polskie Towarzystwo Archeologiczne i Numizmatyczne, Oddział w Nowej Hucie, Muzeum Archeologiczne w Krakowie, Muzeum Okręgowe w Przemyślu), p. 11–33.
Godłowska M.
1976 *Próba rekonstrukcji rozwoju osadnictwa neolitycznego w rejonie Nowej Huty*, Mat. Arch. NH 5, p. 7–179.
Godłowska M.
1986 *Neolityczne osadnictwo na stanowisku 76 w Krakowie-Nowej, Hucie-Branicach*, Mat. Arch. NH 10, p. 7–40.
Gouletquer P., Kleimann D., Weller O.
1994 *Sels et Techniques*, [in:] M.-Y. Daire (ed.), *Les Sel Gaulois. Bouilleurs de sel et ateliers de briquetages armoricains á l'Age du Fer*, Paris (Errance), p. 123–161.

Górski J.
1997 *Główne etapy rozwoju kultury trzcinieckiej na obszarze Nowej Huty na tle przemian tej kultury w Zachodniej Małopolsce*, Mat. Arch. NH 20, p. 7–37.
Górski J.
2007 *Chronologia kultury trzcinieckiej na lessach Niecki Nidziańskiej*, Kraków (Muzeum Archeologiczne w Krakowie).
Grabowska B., Zastawny A.
2011 *Materiały kręgu lendzielsko-polgarskiego ze st. 5 w Modlnicy, pow. krakowski*, [in:] J. Kruk, A. Zastawny (eds.), *Modlnica, st. 5. Od neolitu środkowego do wczesnej epoki brązu*, Kraków, (Krakowski Zespół do Badań Autostrad, sp. J.: Instytut Archeologii Uniwersytetu Jagiellońskiego, Instytut Archeologii i Etnologii PAN, Oddział w Krakowie, Muzeum Archeologiczne w Krakowie), p. 95–172.
Harding A.
2013 *Salt in Prehistoric Europe*, Leiden (Sidestone Press).
Harding A., Kavruk V.
2013 *Explorations in Salt Archaeology in the Carpathian Zone*, Budapest (Archaeolingua).
Jarosz P., Szczepanek A., Wołoszyn M.
2012 *Ratownicze badania wykopaliskowe na stanowiskach 6 i 8 w Zakrzowcu, gm. Niepołomice, woj. małopolskie, w 2007 roku*, [in:] S. Kadrow (ed.), *Raport 2007–2008. tom I*, Warszawa (Narodowy Instytut Dziedzictwa), p. 303–320.
Jodłowski A.
1971 *Eksploatacja soli na terenie Małopolski w pradziejach i we wczesnym średniowieczu*, SMDŻSP 4, p. 1–316.
Jodłowski A.
1976 *Technika produkcji soli na terenie Europy w pradziejach i we wczesnym średniowieczu*, SMDŻSP 5, p. 1–257.
Kadrow S.
2003 *Charakterystyka technologiczna ceramiki kultury łużyckiej*, [in:] S. Kadrow (ed.), *Kraków-Bieżanów, stanowisko 27 i Kraków-Rżąka, stanowisko 1. Osada kultury łużyckiej,* Via Archaeologica. Źródła z badań wykopaliskowych na trasie autostrady A4 w Małopolsce 3, Kraków (Krakowski Zespół do Badań Autostrad sp.j.: Instytut Archeologii Uniwersytetu Jagiellońskiego, Instytut Archeologii i Etnologii PAN, Oddział w Krakowie, Muzeum Archeologiczne w Krakowie), p. 205–220.
Kadrow S., Machnik J.
1997 *Kultura mierzanowicka. Chronologia, taksonomia i rozwój przestrzenny*, Prace Komisji Archeologicznej 29, Kraków (wydawnictwo Polskiej Akademii Nauk, Oddział w Krakowie).
Kaczanowska M.
2006 *Środkowa faza rozwoju kultury lendzielskiej w Małopolsce — grupa pleszowsko-modlnicka*, [in:] M. Kaczanowska (ed.), *Dziedzictwo cywilizacji naddunajskich: Małopolska na przełomie epoki kamienia i miedzi*, Biblioteka Muzeum Archeologicznego w Krakowie 1, Kraków (Muzeum Archeologiczne w Krakowie), p. 37–52.
Kalicki T., Przybyła M. M.
2011 *Wstęp*, [in:] M. M. Przybyła (ed.), *Osadnictwo neolityczne na stanowisku 15 w Krakowie-Bieżanowie* (unpublished; KZdBA).
Klimaszewski M.
1972 *Podział geomorfologiczny Polski Południowej*, [in:] M. Klimaszewski (ed.), *Geomorfologia Polski*, Warszawa (PWN), vol. II, p. 78–98.
Klimek A., Peschel K.
2009 *Materiały krzemienne ze stanowiska Zakrzów 1, pow. wielicki* (unpublished; KZdBA).
Kluzik A.
2010 *Osada kultury pucharów lejkowatych w Krakowie Nowej Hucie-Mogile, stan. 62*, Mat. Arch. NH 25, p. 7–66.

Kruk J., Milisauskas S.
1983 *Chronologia absolutna osadnictwa neolitycznego z Bronocic, woj. Kieleckie*, APolski 28:2, p. 257–320.
Kruk J., Milisauskas S.
1990 *Radiocarbon dating of neolithic assemblages from Bronocice*, Prz. Arch. 37, p. 195–228.
Krushel'nits'ka L.
1993 *Novi pam'yatki kul'tury Gava-Goligrady*, [in]: L. Krushel'nits'ka (ed.), *Pam'yatki gal'shtans'kogo periodu v mezhyrichi Visly, Dnistra i Pryp'yati*, Kyiv (Naukova Dumka), p. 56–122.
Krushel'nits'ka L.
2002 *Pam'yatka solevarinnya rubezhu rann'oi i seredn'oi bronzy v pivnichno-skhidnykh Karpatakh*, Zapyski Naukovogo Tovarystva imeni Shevchenka 224, p. 139–154.
Kulczycka-Leciejewiczowa A.
1969 *Pleszów (Nowa Huta) — osada neolityczna kultury ceramiki wstęgowej rytej i lendzielskiej*, Mat. Arch. NH 2, p. 7–124.
Madej P.
1998 *Inwentarz ceramiczny grupy pleszowskiej kultury mierzanowickiej ze stanowiska w Krakowie-Pleszowie IV/20*, Mat. Arch. NH 21, p. 27–70.
Matthias W.
1961 *Das mitteldeutsche Briquetage-Formen, Verbreitung und Verwendung*, Jahresschrift für Mitteldeutsche Vorgeschichte 45, p. 119–225.
Munteanu R., Garvăn D., Nicola D., Preoteasa C., Dumitroaia G.
2007 *Cucuieți-Slatina Veche (Romania). Prehistoric exploitation of a salt resource*, [in:] D. Monah, G. Dumitroaia, O. Weller, J. Chapman (eds.), *L'Exploitation du sel à travers le temp*, Bibliotheca Memoriae Antiquitatis 18, Piatra-Neamț (Editura Constantin Matasă), p. 57–71.
Pelisiak A.
2008 *Late Neolithic settlement and the salt in the Carpathians*, [in:] T. Kalicki, B. Sz. Szmoniewski (eds.), *Man and mountains: paelographical and archaeological perspectives*, Studies of the Institute of Geography of Jan Kochanowski University 17, Kielce (Instytut Geografii Uniwersytetu Jana Kochanowskiego), p. 51–63.
Petre-Govora G.
1988 *Descoperiri arheologice din Oltenia privind epoca timpurie a bronzului*, Thraco-Dacica 9, p. 137–147.
Przybyła M. M.
2010a *Osadnictwo w epoce brązu i we wczesnej epoce żelazna na terenie stanowiska 1 w Zakrzowie, gm. Niepołomice* (see: http://www.archeo.krakow.pl/badania-archeologiczne/zakrzow-stanowisko-1).
Przybyła M. M.
2010b *Kilka uwag na temat możliwości produkcji soli przez ludność kultury trzcinieckiej w zachodniej Polsce*, [in:] S. Czopek, S. Kadrow (eds.), *Mente et rutro. Studia archeologica Johanni Machnik viro doctissimo octogesimo vitae anno ab amicis, collegis et discipulis oblata*, Rzeszów (Mitel), p. 399–420.
Przybyła M. M.
2012 *Osadnictwo neolityczne na stanowisku 15 w Krakowie-Bieżanowie* (unpublished; KZdBA).
Przybyła M. M, Byrska-Fudali M.
2012 *Osady kultury mierzanowickiej, trzcinieckiej i łużyckiej ze stanowiska 15 w Krakowie-Bieżanowie* (unpublished; KZdBA).
Przybyła M. M., Chudzińska B.
2009 *Osady kultury mierzanowickiej, trzcinieckiej i łużyckiej, oraz z okresu późnego średniowiecza na stanowisku Zakrzów 1, pow. Wielicki* (unpublished; KZdBA).

Przybyła M. M., Chudzińska B., Trela-Kieferling E.
2009 *Materiały pradziejowe i nowożytne ze stanowiska 2 w Zakrzowie, pow. wielicki* (unpublished; KZdBA).
Przybyła M. M., Szczepanik P., Podsiadło M.
2015 *Eneolithic enclosure in Gniazdowice, Proszowice district, Lesser Poland, in light of non-destructive research methods*, [in:] M. Nowak, A. Zastawny (eds.), *The Baden culture around the Western Carpathians* (Krakowski Zespół do Badań Autostrad sp.j.: Instytut Archeologii Uniwersytetu Jagiellońskiego, Instytut Archeologii i Etnologii PAN, Oddział w Krakowie, Muzeum Archeologiczne w Krakowie), p. 337–352.
Rachwaniec A.
1985 *Materiały archeologiczne ze starszego okresu epoki brązu oraz kultury łużyckiej z rejonu Kopca Wandy w Nowej Hucie-Mogile*, Mat. Arch. NH 9, p. 89–191.
Rook E.
1968 *Osady kultur z cyklu wstęgowych w Targowisku, pow. Bochnia*, Mat. Arch. 9, p. 91–136.
Rook E.
1971 *Materiały ceramiki promienistej odkryte na stanowisku Nowa Huta-Pleszów (badania w latach 1954–1963)*, Mat. Arch. NH 4, p. 111–234.
Rook E., Nowak M.
1993 *Sprawozdanie z badań wielokulturowego stanowiska w Krakowie-Prądniku Czerwonym, w latach 1990 i 1991*, Spraw. Arch. 45, p. 35–71.
Szybowicz A.
1981 *Materiały kultury lendzielskiej z Baryczy, stan. VIII*, Badania Archeologiczne prowadzone przez Muzeum Żup Krakowskich w Wieliczce w 1980 roku, p. 5–20.
Tünde H.
2010 *Megfigyelések a középső és késő rézkori kultúrák fazekasáruin alatonőszöd-Temetői dűlő lelőhelyen: készítéstechnikai vizsgálatok*, Archeometriai Műhely 7:1, p. 51–81.
Stefański D.
2011 *Materiały krzemienne ze stanowiska 15 w Krakowie-Bieżanowie* (unpublished; KZdBA).
Weller O., Dumitroaia G.
2005 *The earliest salt production in the world: an early Neolithic exploitation in Poiana Slatinei-Lunca, Romania*, Antiquity 79 (http://www.antiquity.ac.uk/projgall/weller/).
Włodarczak P.
2006 *Chronologia grupy południowo-wschodniej kultury pucharów lejkowatych w świetle dat radiowęglowych*, [in:] J. Libera, K. Tunia (eds.), *Idea megalityczna w obrządku pogrzebowym kultury pucharów lejkowatych*, Lublin–Kraków (Instytut Archeologii i Etnologii PAN, Oddział w Krakowie, Instytut Archeologii UMCS w Lublinie), p. 27–66.
Zastawny A.
1999 *Uwagi na temat chronologii osadnictwa kultury badeńskiej w zachodniej części Małopolski*, Spraw. Arch. 51, p. 9–55.
Zastawny A.
2000 *Kultura badeńska w regionie wielicko-bocheńskim — stan i problematyka badań*, Spraw. Arch. 52, p. 9–47.

Address of the Author
Pl. Serkowskiego 8/3
30-512 Kraków, Polska
e-mail: archeo.pryncypat@interia.pl